MOISTURE CHANGE IN COTTON BALES STORED IN DIFFERENT BAGGING

W. Stanley Anthony
Agricultural Research Service, USDA
U.S. Cotton Ginning Laboratory
Stoneville, MS

ABSTRACT

The density of baled cotton as well as the storage climate and permeability of the protective covering on the bale all influence the rate of moisture gain and loss as well as the bale thickness. Eight bales of cotton were packaged at universal density and stored without bagging at ambient conditions for 81 days (Phase I). The bale thickness was measured periodically and the bale weights were measured before and after the storage period. The same eight bales were randomly placed in four different types of bagging and stored at 26.7° C (80° F) and 80% relative humidity (RH) for 100 days (Phase II). The bagging included two types of experimental bagging and two types of standard bagging. The experimental bagging was less permeable than the standard bagging. Then, the same bales were stored for 305 days at 21.1° C (70° F) and 50% RH (Phase III). For Phases II and III, the bales were weighed and their thickness measured about twice weekly. The bales gained moisture for Phases I and II but lost moisture (weight) for Phase III. Bale thickness increased initially after storage as climatic conditions fluctuated during Phase I. During Phase II at 80% RH, the bale thickness increased. However, during Phase III at 50% RH, the thickness decreased. The experimental bagging restricted the change in weight gain and loss more than did the standard bagging.

INTRODUCTION

The Joint Cotton Industry Bale Packaging Committee (JCIBPC) was established in 1968 to improve the physical condition of cotton bales produced in the United States. The change in the cotton industry to net weight trading opened the door to numerous advancements in lightweight bale bagging and ties. For marketing based on gross weight, the heavy packaging materials offered considerable economic advantage. Thus, in 1968, bales were covered in jute and restrained by flat steel bands with a tare weight of 9.5 kg (21 lb.). Currently, most bales are packaged in woven polypropylene or polyethylene film and restrained with wire ties, and have a tare weight of less than 2.3 kg (5 lb.). As bale storage and handling practices change and new technology emerges, new types of bagging and ties are developed in response to the new requirements. The JCIBPC thoroughly investigates new bagging and tie materials to ensure that they perform satisfactorily before approving widespread commercial use. Some of the initial evaluation of the new materials is done at the U.S. Cotton Ginning Laboratory at Stoneville, MS. The Stoneville studies usually involve accelerated conditioning at high or low humidity in order to quickly assess the response of the new materials prior to commercial testing.

After the cotton fiber is packaged into a bale, moisture transfer occurs very slowly especially at high densities. In fact, bales at densities of 192 kg/m3 (12 lb/ft3) required over 60 days to equilibrate with the environment while bales at 448 kg/m3 (28 lb/ft3) required over 110 days (Anthony, 1982). The bales attempt to reach equilibrium with the environment. The rate of adsorption and desorption is influenced by bale density, ambient temperature and humidity, bale covering, surface area, air changes, fiber history, etc. (Anthony, 1997). Anthony (1982) stored low-moisture bales for periods up to one year in jute, burlap, woven polypropylene, strip-laminated woven polypropylene, dimpled polyethylene and polyethylene bagging. Bales covered in the relatively impermeable polyethylene required much more time (over 365 days) to equilibrate with the environment than the other bale coverings (over 120 days).

Anthony and Herber (1991) studied the moisture transfer characteristics of universal density bales in burlap, woven polypropylene with laminated strips of polyethylene to prevent fibrillation, and polyethylene with 0.95 cm (3/8-in.) diameter perforations on 45.7 cm (18-in.) centers to allow air to escape during bag emplacement. The bales were packaged at 3.5% moisture and stored at 21.1 °C (70 ºF) and 80% RH. They reported that the woven polypropylene-covered bales reached equilibrium in less than 161 days, whereas the polyethylene-covered bales had not reached equilibrium after 378 days. After 161 days, the polyethylene-covered bales had gained only about 40% as much moisture as the polypropylene-covered bales. Barker and Laird (1993) reported that desorption occurs at about twice the rate of adsorption for small samples of lint. Thus, bales should lose moisture much faster than they gain moisture.

In 2002, U.S. bales were packaged mostly in woven polypropylene (strip-coated or fully coated) (53%), polyethylene (39%), and burlap, (8%) (Thompson, 2003). The cotton industry is seeking a bagging that does not allow foreign matter to enter, but does allow moisture transfer. These two features are not compatible in the same bagging, thus a compromise must be reached in permeability. The traditional strip-coated woven polypropylene bag is strong and allows adequate moisture transfer. The traditional, relatively impermeable polyethylene bag limits contamination from dust and dirt but is weak and does not allow rapid moisture transfer. Merging these two features (strength and permeability) into one bagging can be accomplished by sacrificing some permeability and fully coating the interior (or exterior) of a woven polypropylene bag with a thin layer of polyethylene. However, this must be carefully done so that adequate permeability to moisture can be retained. In addition, bales are normally "stuffed" into the bale bag mechanically through the one open end, and the cotton bale rapidly displaces the air in the bag. As a result, a means for the air to exit must be provided. This can be done by cutting slots or holes near the sealed end of the bag or by omitting sections of the coating. Both of these alternatives are currently available.

PURPOSE

The purpose of this research was to determine the change in bale weight of universal density cotton bales stored at known humidities for extended periods of time.

METHODOLOGY

The Continental Bespress® at the U.S. Cotton Ginning Laboratory was used to compress the bales of cotton for this study using three different types of compression surfaces called platens. The standard Bespress® is equipped with platens that have the outside edges turned upward (Figure 1) in order to 1) pre-form the bale slightly, 2) make it easier to install bale ties, and 3) prevent the cotton from interfering with the insertion of the bale ties. This is true both for the upper and lower platens. Other presses common in the cotton industry, however, use flat platens. For one of the treatments in this study, the standard bottom platen was converted to a flat platen by installing wooden inserts to counter the height of the shaped section of the platen (Figure 2), and to make the platen appear flat when the wood was installed on the top and bottom platens. For the third treatment, the standard bottom platen was replaced with the cast steel bottom platen (Figure 3) developed under patent number 5,852,969. The shaped top platen was converted to flat by installing wooden inserts similar to the procedure used for the bottom platen. Due to operational constraints, the top platen was flat for all three treatments.

The thickness of the bales was measured at each of the seven "humps" or bulges between the eight ties using calipers equipped with flat plates to expand the contact surface area (Figure 4). The thickness of the bale between the ties is usually a function of tie spacing, tie length, moisture content, and bagging.

Phase I

Eight bales of cotton of the Stoneville 4892 BR variety were ginned and compressed to a density of about 672 kg/m3 (42 lb/ft3) (Table 1). The average bale weight was targeted at 227 kg (500-lb) in order to ensure that the typical weight of the bales being compressed in the industry was considered.

The bales were stored without any bagging (naked) in Building 21 (Figure 5) at the Stoneville Ginning Laboratory from November 16, 2001 to February 4, 2002. The bales were allowed to adjust to whatever humidity and temperature was available in the air during the storage period. The bales changed moisture content continuously during storage, but the bales were only weighed before storage and after storage because of concern that movement of the bales might change the tension on the bale ties and cause tie failure. The thickness of the bale at each of the seven humps was measured twice weekly for about 80 days while the bales were exposed to the temperature and humidity in the gin.

Phase II

The eight bales of cotton were then placed in four different types of bale covering materials (Table 2) and stored under controlled conditions. The bale coverings were as follows: 1) Specification woven polypropylene spiral sewn bags with alternating extrusion-coated and uncoated strips, 7.6 cm (3-in.) wide, 12 x 8 bag construction (manufactured by L.P. Brown), 2) specification woven polypropylene spiral sewn bags with alternating extrusion coated and uncoated strips 7.6 cm (3-in.) wide, 1050 by 1050, with a 10 x 7 bag construction (manufactured by

AMOCO), 3) fully coated, woven polypropylene spiral sewn bags with coated seams with 20 each 3.8 cm (1½-in.) moon shaped vent holes (manufactured by AMOCO), and 4) fully coated, woven polypropylene spiral sewn bags with 7.6 cm (3-in.) wide seams, 12 x 8.5 bag construction (manufactured by Langston Co.). Two bales were covered in each of these test materials. The bales were stored in a conditioning chamber in Building 27 at 26.7° C (80° F) and 80% relative humidity. Thickness at hump 5 and bale weight were recorded 2 or 3 times per week for about 100 days while the bales were exposed to the temperature and humidity in the room. As the bales were weighed, they were rotated to a different location in the conditioning room.

Phase III

The bales were then moved to a conditioning chamber in Building 21 and stored at 21.1° C (70° F) and 40 to 50% relative humidity for 305 days. The bale weight was recorded 2 or 3 times per week while the bales were exposed to the temperature and humidity in the room. As the bales were weighed, they were rotated to a different location in the conditioning room.

RESULTS AND DISCUSSION

Phase I

The data collected during the initial packaging of the bales for Phase I are shown in Table 1. For the eight bales in this study, the moisture content after ginning averaged about 5% and ranged from 4.4 to 5.9%. Initial bale weights ranged from 224 to 232 kg (494 to 511 lb). Compression densities averaged 672 kg/m3 (42 lb/ft3) but ranged from 632 to 699 kg/m3 (39.5 to 43.7 lb/ft3). High Volume Instrument data as determined by the USDA, Agricultural Marketing Service is at Table 3 and identifies the marketing properties of the bales. The data indicates that the fiber properties were quite similar for the bales.

Bale weights after the first phase of storage (no bagging and no relative humidity or temperature control, Table 4) ranged from 229 to 238 kg (504 to 524 lb). After 81 days, estimated bale moisture contents averaged 5.9% and ranged from 5.6 to 6.3%. The increase in moisture averaged 0.86% or the equivalent of 1.95 kg (4.3 lb).

The average bale thickness at the hump was significantly different for "Platen" and for "Day of Storage" but not for their interaction (Table 5). The average bale thickness at the hump was 82 cm (32.3-in.) across all bales and was 80.3, 81.3, 83.6 cm (31.6, 32.0, and 32.9-in.) for the flat, standard, and cast platens, respectively (Table 6). The thickness for each type platen as a function of days of storage is at Table 7 and is also plotted in Figure 6.

Phase II

The bales during storage are shown in Figure 7. The types of bagging material used in this study included specification woven polypropylene bags with extrusion-coated strips to prevent fibrillation as well as similar bags that were fully coated on the interior to reduce contamination.

The weight change (final – initial) averaged 2% and was 2.3, 2.2, 2.0, and 1.5%, respectively, for types 1, 2, 3, and 4 bagging. Weight change averaged 1.48, 1.35, 1.25 and 0.8% for the entire storage period (Table 8). The first two types were the strip-coated bagging and the second two types were the fully coated bagging.

Final moisture contents were not measured but were estimated to be about 7.9% based on the weight gain and the initial moisture. Based on initial moisture contents of 6.3, 6.1, 5.8, 6.3, 5.6, 5.8, 5.8 and 5.6% estimated for bales 949-956 and the weight gain, final bale moistures after storage at 80% relative humidity were 7.7, 7.7, 8.0, 8.6, 7.9, 7.8, 8.0 and 7.8%, respectively.

The change in weight gains as a function of days of storage (moisture) is shown in Figure 8. The types of bagging follow a different slope but the type 4 bagging (fully coated woven polypropylene with 3-inch wide seam uncoated), appeared to gain weight much more slowly than the other materials.

Thickness in the bale at the bale hump generally increased from 0.51 up to 1.27 cm (0.2 up to .5-in.). The thickness at the hump versus day of storage is shown in Figure 9 and suggests that the thickness of the bale increased initially and then remained relatively constant for the remainder of the storage period. The average thickness is given in Table 8.

Phase III
Bales during storage in the conditioning room of Building 21 are partially shown (due to camera restraints) in Figure 10. Initial moisture content was assumed to be the final bale weight for Phase II adjusted for weight change in the 10 days that elapsed while the bales were not in a controlled environment. Initial weight and thickness measurements were taken on the first day of Phase III.

Bale weights, moisture and thickness measurements at the conclusion of Phase III are summarized in Tables 4 and 6. Bale weight decreased 2.44, 2.25, 1.73, and 1.61% for Types 1, 2, 3, and 4 bagging, respectively, on average. Bale weight decreased for all the bales (Figure 11), but changed more rapidly than the fully coated bales. Thickness data was quite variable (Figure 12) and appears to represent more variability in the measurement techniques than response to moisture change.

SUMMARY AND CONCLUSIONS

The response of universal density cotton bales packaged with different shaped platens, placed in different types of bagging, and stored at different humidities was considered in three phases. In Phase I, eight bales of cotton were compressed with three different shapes of platens and stored in an ambient environment. In Phase II, these same bales were randomly placed in four different types of bagging and stored at 26.7° C (80° F) and 80% RH for 100 days. In Phase III, the same bales were stored for 305 days at 21.1° C (70° F) and 50% RH. For Phase I, the bales were weighed before and after storage. For Phases II and III, the bales were weighed and their thickness measured about twice weekly.

The response of bale weight to storage conditions is shown in Figure 13 for all three phases. The bales gained moisture for Phases I and II but lost moisture (weight) for Phase III. Bale thickness increased initially after storage as climatic conditions fluctuated during Phase I (Figure 14). During Phase II at 80% RH, bale thickness increased. However, during Phase III at 50% RH, the thickness decreased. Bale thickness measurements fluctuated substantially due to measurement techniques, thus the techniques need improvement. The bales averaged 81.9 cm (32.25 in.) thick at the beginning of Phase I and were 82.7, 85.3 and 84.8 cm (32.55, 33.58, and 33.38 in.) after Phases I, II and III.
Disclaimer

Mention of a trade name, propriety product or specific equipment does not constitute a guarantee or warranty by the United States Department of Agriculture and does not imply approval of a product to the exclusion of others that may be suitable.

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Table 1. Summary of test conditions for bales ginned May 21, 2001 and stored until Apri1 3, 2003 (Phase I).

Gin ID	Platen[1]	Bale number	Bale weight, initial kg.	Compression density, kg/m³	Moisture, initial, %
1	FLAT	949	231	699.2	5.9
2	CAST	950	227	640.0	5.5
3	FLAT	951	225	680.0	5.4
4	CAST	952	224	632.0	5.2
5	STANDARD	953	228	689.6	4.8
6	CAST	954	232	654.4	4.6
7	STANDARD	955	229	692.8	4.6
8	STANDARD	956	228	689.6	4.4

[1] Top platen = flat.
[2]Moisture estimated based on initial moisture and weight changes during storage.

Table 2. Types of bagging material used in the study (02-363)

Bagging	Types of bale covering material
1. WPP striped w/ spec strips (WPP Brown)	Specification Woven Polypropylene Spiral Sewn Bags w/ alternating extrusion-coated and uncoated strips, 7.6 cm (3-in.) wide strips, 12 x 8 bag construction (L. P. Brown)
2. WPP striped w/ ETP pattern (WPP Amoco)	Specification Woven Polypropylene Spiral Sewn Bags w/ alternating extrusion-coated and uncoated strips, 7.6 cm (3-in.) wide strips, 1050 by 1050, 10 x 7 bag construction (AMOCO).
3. WPP fully-coated & spiral sewn seam (Moon)	Experimental Test Program - Fully-coated Woven Polypropylene, gusseted, Spiral Sewn Bags with coated seams, with 20 each, 3.8 cm (1½-in.) diameter half-moon vent holes (AMOCO). 1050 by 1050, 10 x 7, PROPEX, Bag Length – 241.3 cm (95-in.), bag Width – 252.7 cm (99.5-in.)
4. WPP fully-coated & spiral sewn seam (Langston)	Experimental Test Program - Fully-coated Woven Polypropylene Spiral Sewn Bags with 7.6 cm (3-in.) wide uncoated seam, 12 x 8.5 bag construction (*Langston*). Seam Length top to bottom – 350.5 cm (138-in.), Bag Length – 236.2 cm (93-in.), Bag Width – 243.8 cm (96-in.).

Table 3. Initial High Volume Instrument data.

Bale No.	Color	Leaf	Micronaire	Strength, g/tex	Rd	Plusb	% Area	Length, cm	Uniformity
949	32	4.0	4.30	30.36	72.4	9.98	0.52	2.84	82.4
950	31	4.0	4.34	30.28	73.6	9.76	0.42	2.84	81.8
951	31	4.0	4.24	29.94	74.4	9.36	0.40	2.82	82.4
952	32	4.0	4.48	30.36	71.4	10.50	0.46	2.82	83.0
953	31	4.0	4.40	30.96	73.8	9.74	0.36	2.79	81.4
954	31	3.4	4.44	30.90	75.4	9.26	0.34	2.79	82.0
955	32	4.0	4.40	29.02	73.6	9.72	0.40	2.84	82.6
956	31	3.8	4.44	29.78	75.0	9.20	0.36	2.82	81.2

Table 4. Moisture and bale weight after storage for Phases I, II, and III.

Gin ID	Bale number	Bagging[1]	Moisture, %			Bale weight (kg)		
			After atmospheric storage	After 80% RH storage	After 50% RH storage[3]	After atmospheric storage, kg[2]	After storage at 80% RH, kg[2]	After storage at 50% RH, kg[2]
1	949	4	6.3	7.7	5.4	235	239	233
2	950	4	6.1	7.7	4.8	232	236	229
3	951	3	5.8	8.0	5.2	229	235	228
4	952	1	6.3	8.6	4.9	229	236	227
5	953	1	5.6	7.9	4.8	233	240	232
6	954	3	5.8	7.8	4.8	238	244	237
7	955	2	5.8	8.0	4.5	235	242	233
8	956	2	5.6	7.8	4.7	234	241	233

[1] Type 1=wppbrown, 2=wppAMOCO, 3=moon, 4=Langston. Bagging was not applied until the start of Phase II.
[2] Bale moisture estimated based on initial moisture and weight changes during storage
[3] Oven-based moistures were 5.2, 4.8, 4.8, 4.7, 4.7, 5.0, 4.7, and 4.8% for bales 1-8, respectively.

Table 5. Analyses of variance with the General Linear Models procedure for average thickness at the hump for Phase I.

	Mean squares	F Value	Pr > F
Error	0.01400343		
Platen	14.06613081	1004.48	< .001
Days of Storage	0.84196848	60.13	< .001
Platen*Days	0.01748454	1.25	0.2370
R-Square	Coeff Var	Root MSE	Mean
0.977284	0.366906	0.118336	32.25240

Table 6. Bale thickness after storage for Phases I, II, and III.

Gin ID	Bale number	Bagging[1]	Thickness, cm		
			After atmospheric storage (Phase I)	After 80% RH storage (Phase II)	After 50% RH storage (Phase III)
1	949	4	80.87	83.03	82.87
2	950	4	84.30	86.04	85.88
3	951	3	81.46	84.46	83.82
4	952	1	84.18	86.04	85.57
5	953	1	82.84	84.30	84.14
6	954	3	84.66	87.16	86.36
7	955	2	82.41	85.09	84.61
8	956	2	82.75	86.04	85.09

[1] Type 1=wppbrown, 2=wppAMOCO, 3=moon, 4=Langston.

Table 7. Summary of data for the thickness at the hump for bales in Phase I. The bales did not have bagging.

Treatment[1]	Days	Thickness, cm
1	0	78.5
1	3	79.6
1	4	79.4
1	5	79.5
1	10	79.7
1	17	80.0
1	24	80.5
1	31	80.7
1	52	80.9
1	59	80.9
1	67	80.7
1	73	81.0
1	80	81.2
2	0	79.3
2	3	80.9
2	4	80.4
2	5	80.6
2	10	80.9
2	17	81.1
2	24	82.0
2	31	82.1
2	52	82.4
2	59	82.4
2	67	82.3
2	73	82.6
2	80	82.7
3	0	82.1
3	3	83.3
3	4	82.7
3	5	82.8
3	10	82.9
3	17	83.2
3	24	83.9
3	31	83.9
3	52	84.0
3	59	84.1
3	67	83.9
3	73	84.1
3	80	84.4

[1] Treatment: 1-- Bottom platen= flat, 2—standard bottom platen, 3 = cast bottom platen. Top platen = flat for all treatments.

Table 8. Weight and thickness change for Phase II, averaged across days for the storage period at 80% relative humidity.

Bagging[1]	Weight change, %	Thickness, cm
1-Striped - Brown	1.48	85.27
2-Striped - Amoco	1.35	85.47
3-Full-Amoco	1.25	85.83
4-Full-Langston	0.80	84.84

[1] Type 1. Woven polypropylene, striped with specification strips (Brown); Type 2. Woven polypropylene striped with experimental test program pattern (AMOCO); Type 3. Woven polypropylene fully-coated, spiral sewn seam (PROPEX), coated seams with 20 each, half-moon vent holes (AMOCO); Type 4. Woven polypropylene fully-coated, spiral sewn seam, uncoated seams (Langston).

Table 9. Weight change and thickness averaged across storage for 305 days at 50% relative humidity for Phase III.

Bagging[1]	Weight change, %	Thickness change, cm
1-Striped - Brown	-2.44	-0.30
2-Striped - Amoco	-2.25	-0.33
3-Full-Amoco	-1.73	-0.39
4-Full-Langston	-1.61	-0.32

[1] Type 1. Woven polypropylene, striped with specification strips (Brown); Type 2. Woven polypropylene striped with experimental test program pattern (AMOCO); Type 3. Woven polypropylene fully-coated, spiral sewn seam (PROPEX), coated seams with 20 each, half-moon vent holes (AMOCO); Type 4. Woven polypropylene fully-coated, spiral sewn seam, uncoated seams (Langston).

Table 10. Weight change (%) and thickness, (cm) of storage for bales bagged in specification woven polypropylene with 5.1 cm (2-in) wide extruded strips and bales fully covered with an extrusion coating (Phase III).

Type bagging[1]	Days of storage	Weight change %	Thickness at hump, cm
1	0	0	84.05
1	2	0.24	84.53
1	8	0.52	84.86
1	10	0.63	85.01
1	14	0.72	85.09
1	16	0.80	85.17
1	18	0.75	85.17
1	21	0.85	85.24
1	23	0.92	85.32
1	25	0.95	85.32
1	28	1.01	85.42
1	30	1.08	85.50
1	32	1.09	85.50
1	35	1.19	85.57
1	37	1.28	85.57
1	39	1.28	85.57
1	42	1.33	85.57
1	44	1.38	85.57
1	46	1.43	85.57
1	49	1.44	85.50
1	51	1.55	85.42
1	53	1.57	85.42
1	56	1.54	85.45
1	58	1.60	85.17
1	60	1.66	85.17
1	63	1.72	85.32
1	65	1.84	85.32
1	67	1.87	85.32
1	70	1.95	85.50
1	72	1.99	85.50
1	74	1.90	85.01
1	77	1.98	85.17
1	79	2.01	85.17
1	81	2.03	85.17
1	84	2.10	85.17
1	86	2.14	85.17
1	88	2.17	85.17
1	91	2.26	85.17
1	93	2.26	85.17
1	95	2.29	85.17
1	98	2.26	85.17
1	100	2.26	85.17

Table 10. Weight change (%) and thickness, (cm) of storage for bales bagged in specification woven polypropylene with 5.1 cm (2-in) wide extruded strips and bales fully covered with an extrusion coating (Phase III). Continued.

Type bagging	Days of storage	Weight change, %	Thickness at hump, cm
2	0	0	84.30
2	2	0.10	84.68
2	8	0.35	85.01
2	10	0.44	85.09
2	14	0.63	85.17
2	16	0.66	85.24
2	18	0.65	85.24
2	21	0.71	85.32
2	23	0.74	85.42
2	25	0.84	85.42
2	28	0.88	85.57
2	30	0.94	85.57
2	32	1.01	85.57
2	35	1.10	85.57
2	37	1.17	85.73
2	39	1.24	85.73
2	42	1.25	85.73
2	44	1.29	85.73
2	46	1.30	85.73
2	49	1.30	85.73
2	51	1.47	85.65
2	53	1.51	85.65
2	56	1.43	85.65
2	58	1.56	85.65
2	60	1.57	85.65
2	63	1.65	85.57
2	65	1.72	85.57
2	67	1.76	85.57
2	70	1.85	85.57
2	72	1.91	85.57
2	74	1.80	85.32
2	77	1.92	85.50
2	79	1.93	85.50
2	81	1.96	85.50
2	84	2.02	85.50
2	86	2.06	85.50
2	88	2.11	85.50
2	91	2.21	85.50
2	93	2.21	85.65
2	95	2.22	85.65
2	98	2.18	85.65
2	100	2.18	85.57

Table 10. Weight change (%) and thickness (cm) for 100 days of storage for bales bagged in specification woven polypropylene with 5.1 cm (2-in) wide extruded strips and bales fully covered with an extrusion coating (Phase III). Continued.

Type bagging	Days of storage	Weight change, %	Thickness at hump, cm
3	0	0	84.46
3	2	0.16	84.94
3	8	0.39	85.57
3	10	0.45	85.57
3	14	0.60	85.65
3	16	0.62	85.73
3	18	0.61	85.80
3	21	0.70	85.88
3	23	0.70	85.95
3	25	0.80	85.95
3	28	0.84	85.95
3	30	0.86	86.06
3	32	0.9	86.06
3	35	0.99	86.13
3	37	1.02	86.13
3	39	1.04	86.13
3	42	.	86.13
3	44	1.19	86.13
3	46	1.21	86.13
3	49	1.32	86.49
3	51	1.31	86.06
3	53	1.33	86.06
3	56	1.32	85.95
3	60	1.40	87.00
3	63	1.49	85.95
3	65	1.52	85.95
3	67	1.56	85.95
3	70	1.66	85.88
3	72	1.66	85.95
3	74	1.65	85.57
3	77	1.68	85.65
3	79	1.78	85.73
3	81	1.79	85.73
3	84	1.81	85.73
3	86	1.85	85.73
3	88	1.90	85.73
3	91	1.97	85.73
3	93	1.92	85.73
3	95	1.97	85.73
3	98	2.03	85.80
3	100	2.05	85.80

Table 10. Weight change (%) and thickness (cm) for 100 days of storage for bales bagged in specification woven polypropylene with 5.1 cm (2-in) wide extruded strips and bales fully covered with an extrusion coating (Phase III). Continued.

Type of bagging	Days of storage	Weight change, %	Thickness at hump, cm
4	0	0	84.05
4	2	0.05	84.30
4	8	0.18	84.53
4	10	0.23	84.53
4	14	0.30	84.61
4	16	0.34	84.68
4	18	0.35	84.79
4	21	0.37	84.86
4	23	0.40	84.86
4	25	0.46	85.01
4	28	0.50	85.01
4	30	0.50	85.01
4	32	0.52	85.01
4	35	0.57	85.01
4	37	0.61	85.09
4	39	0.63	85.09
4	42	0.65	85.09
4	44	0.67	85.09
4	46	0.72	85.09
4	49	0.67	85.09
4	51	0.79	85.09
4	53	0.82	85.09
4	56	0.86	85.34
4	57	0.86	85.12
4	60	0.89	84.86
4	63	0.95	85.01
4	65	1.01	85.01
4	67	1.03	85.01
4	70	1.08	85.17
4	72	1.12	85.17
4	74	1.06	84.68
4	77	1.17	84.86
4	79	1.18	84.68
4	81	1.23	84.68
4	84	1.25	84.68
4	86	1.28	84.68
4	88	1.30	84.68
4	91	1.36	84.68
4	93	1.38	84.68
4	95	1.38	84.61
4	98	1.45	84.61
4	100	1.47	84.53

[1] 1. Woven polypropylene, striped with specification strips (Brown); 2. Woven polypropylene striped with experimental test program pattern (AMOCO); 3.Woven polypropylene fully-coated, spiral sewn seam (PROPEX), coated seams with 20 each, half-moon vent holes (AMOCO); 4. Woven polypropylene fully-coated, spiral sewn seam, uncoated seams (Langston).

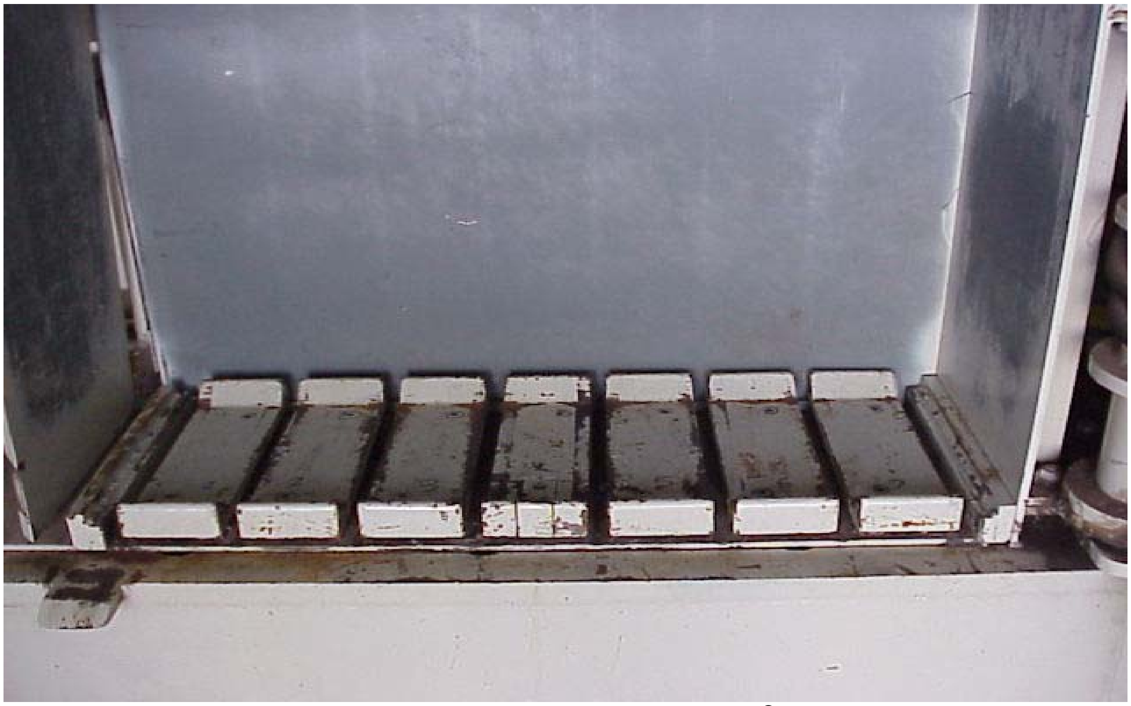

Figure 1. Standard bottom platen for Continental Bespress®. Note the“wings” on each side that pre-form bales to make it easier to install bale ties.

Figure 2. Wooden inserts installed on the standard platen. Similar ones were used on the top platen for all treatments.

Figure 3. Cast steel platen used on the bottom platen.

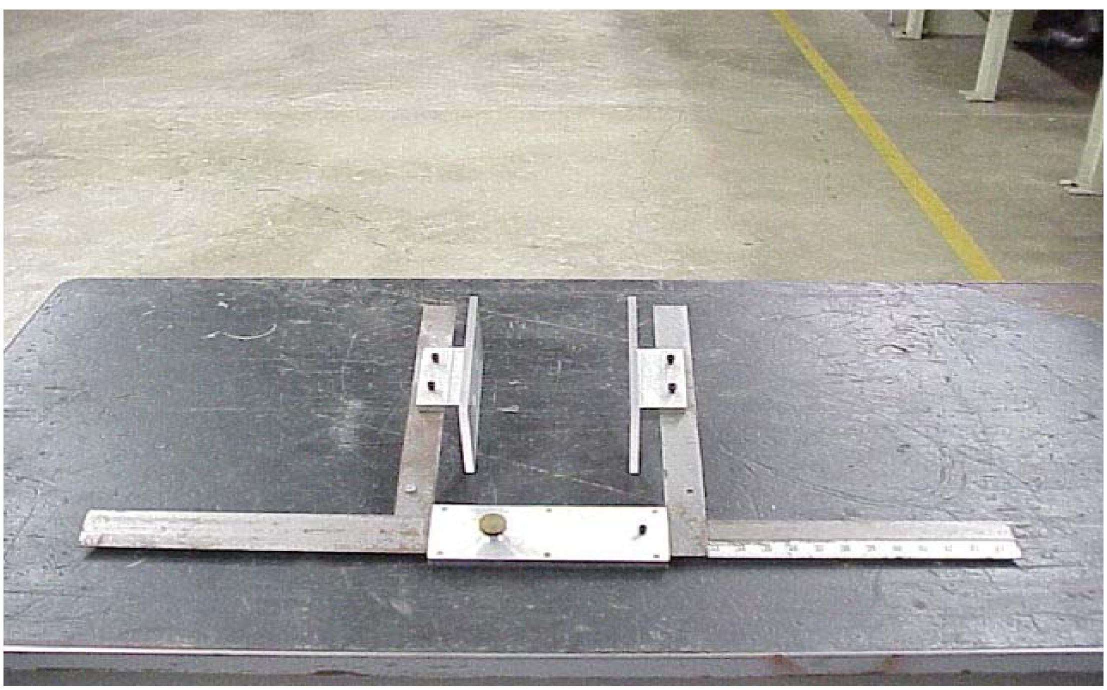

Figure 4. Two carpenters squares were joined together using a sliding mechanism with setscrews. Wide flanges were added to help measure the thickness at the hump.

Figure 5. Bales stored in Building 21 (Phase I).

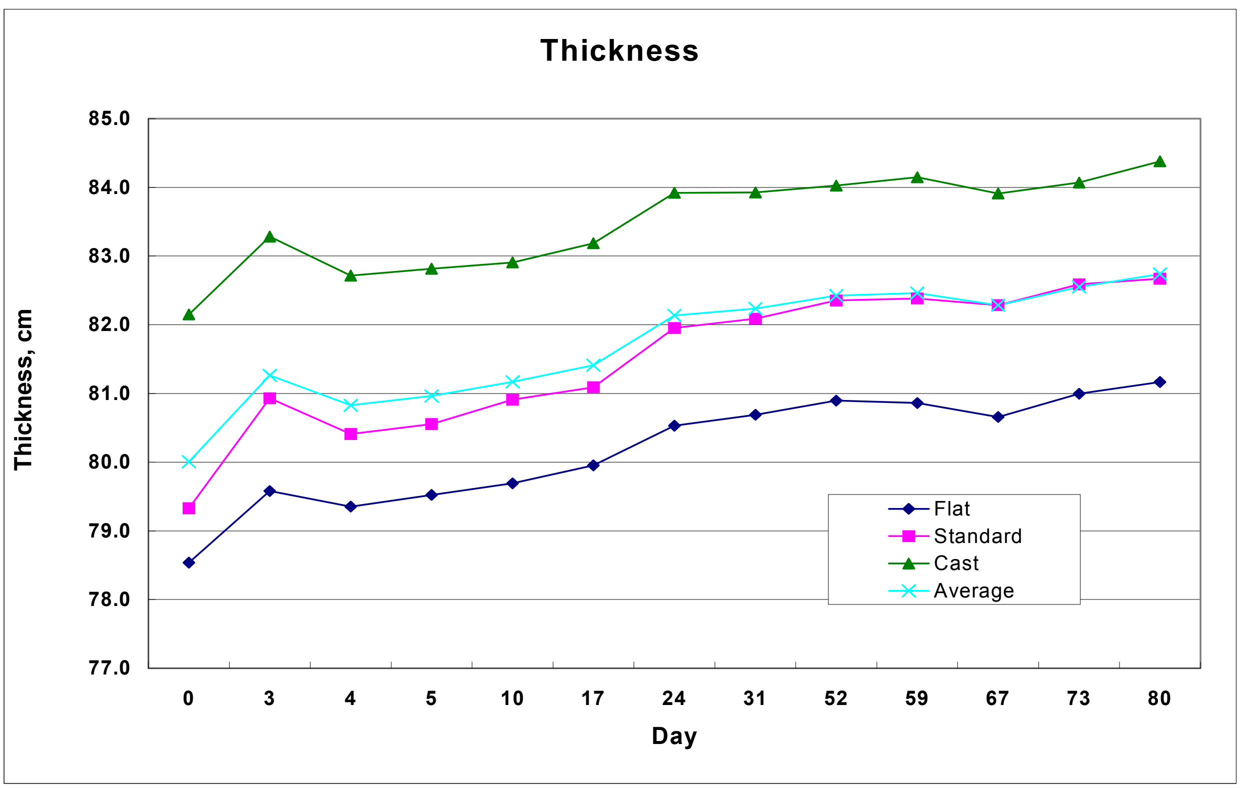

Figure 6. Thickness averaged across all seven "humps" as a function of storage days for three types of platens for Phase I.

Figure 7. Bales stored in the conditioning room of Building 27 (Phase II).

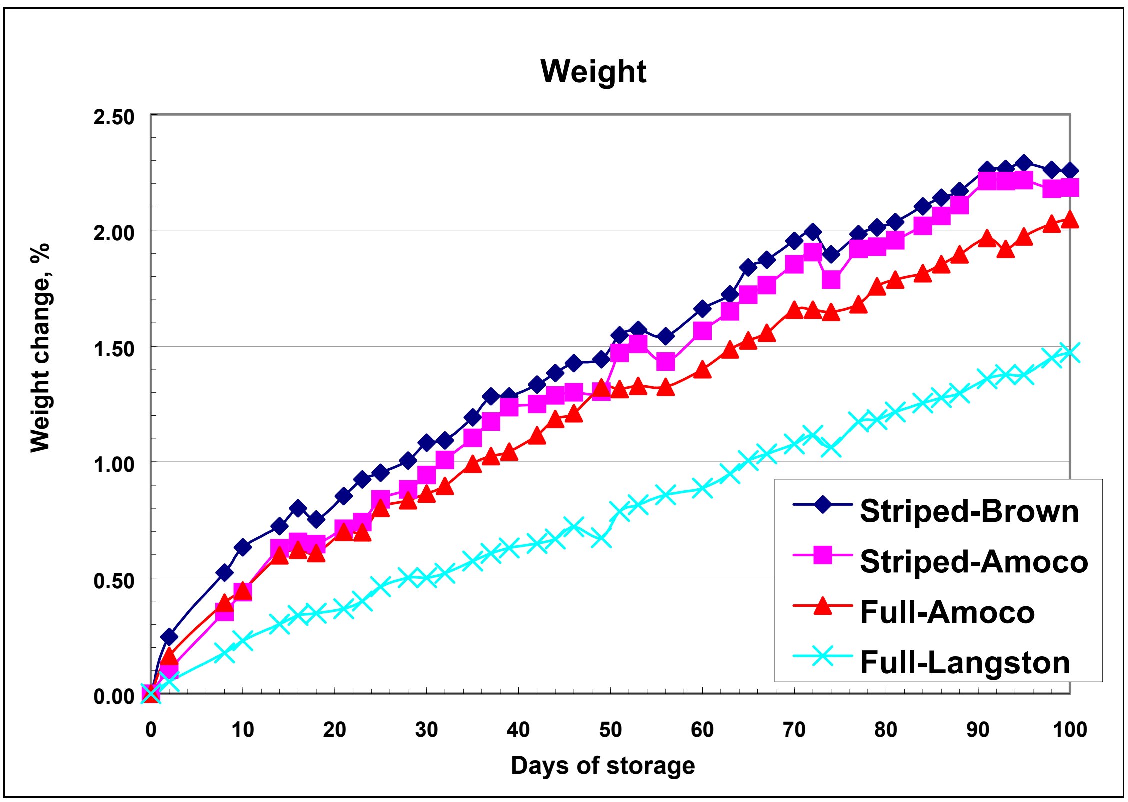

Figure 8. Weight gain, %, as a function of days of storage at 80º C and 80% relative humidity for universal density bales covered in four types of bagging for Phase II.

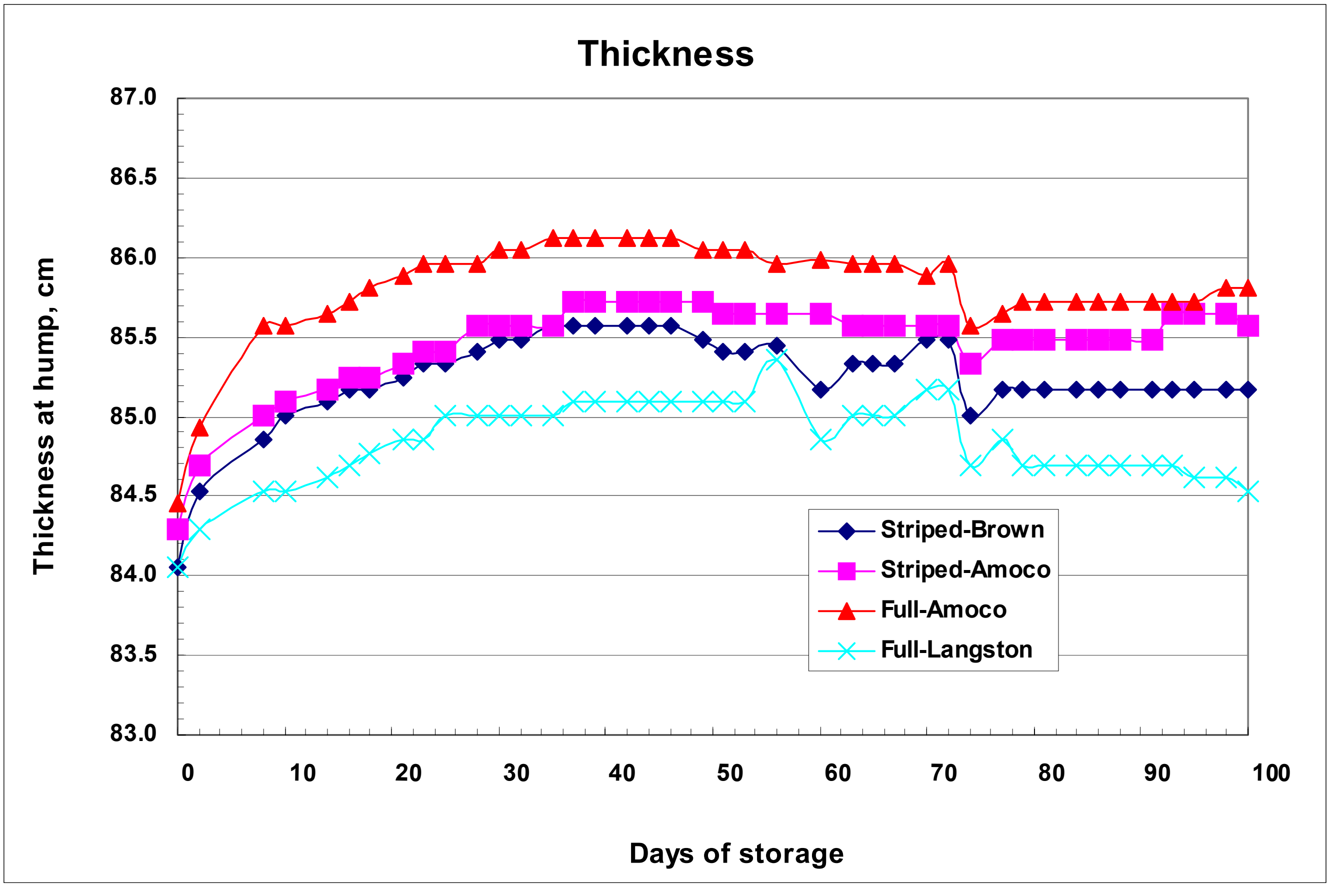

Figure 9. Thickness at hump, in., as a function of days of storage at 80º C and 80% relative humidity for universal density bales covered in four types of bagging for Phase II.

Figure 10. Bales in storage for Phase III.

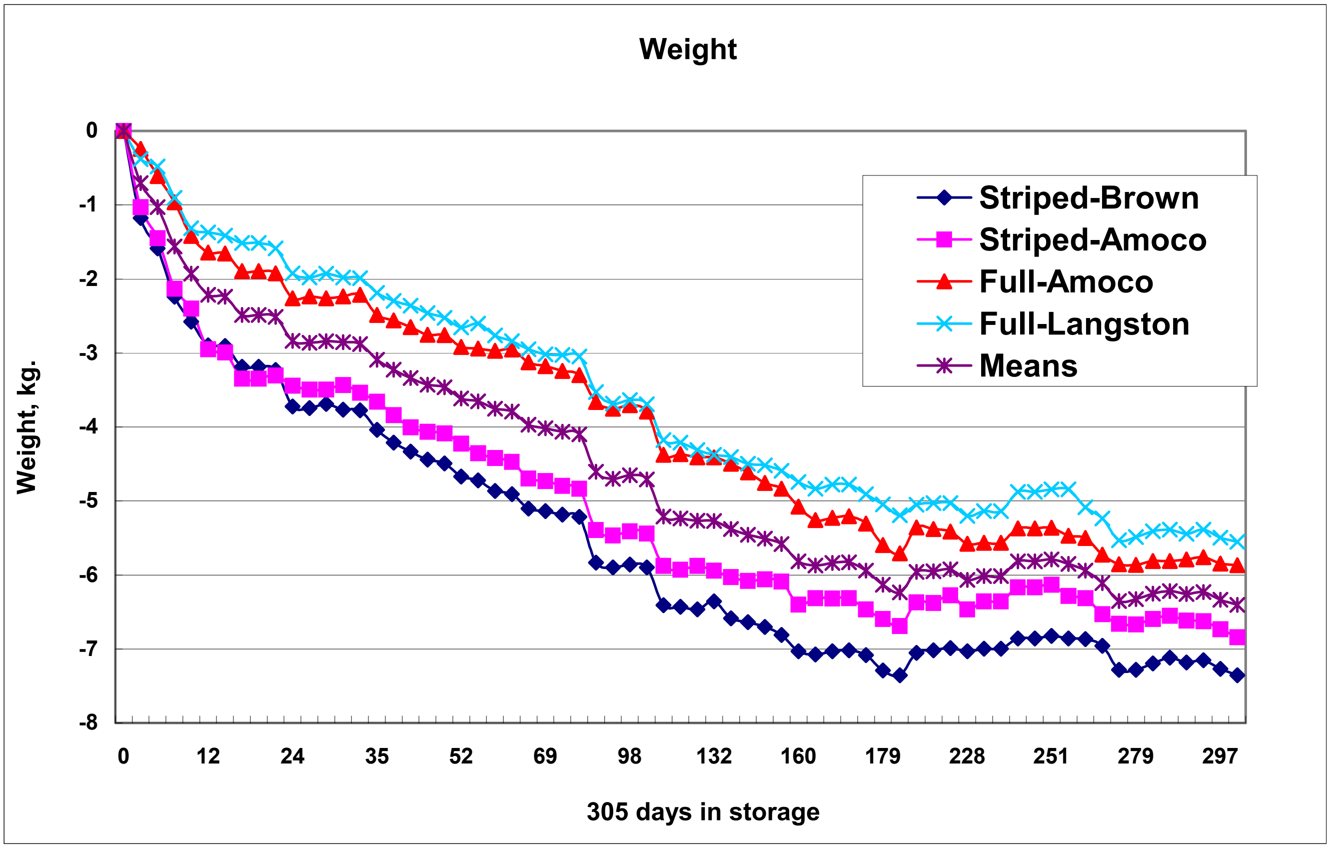

Figure 11. Bale weight change as a function of storage days at 21.1° C (70° F) and 50% relative humidity for Phase III.

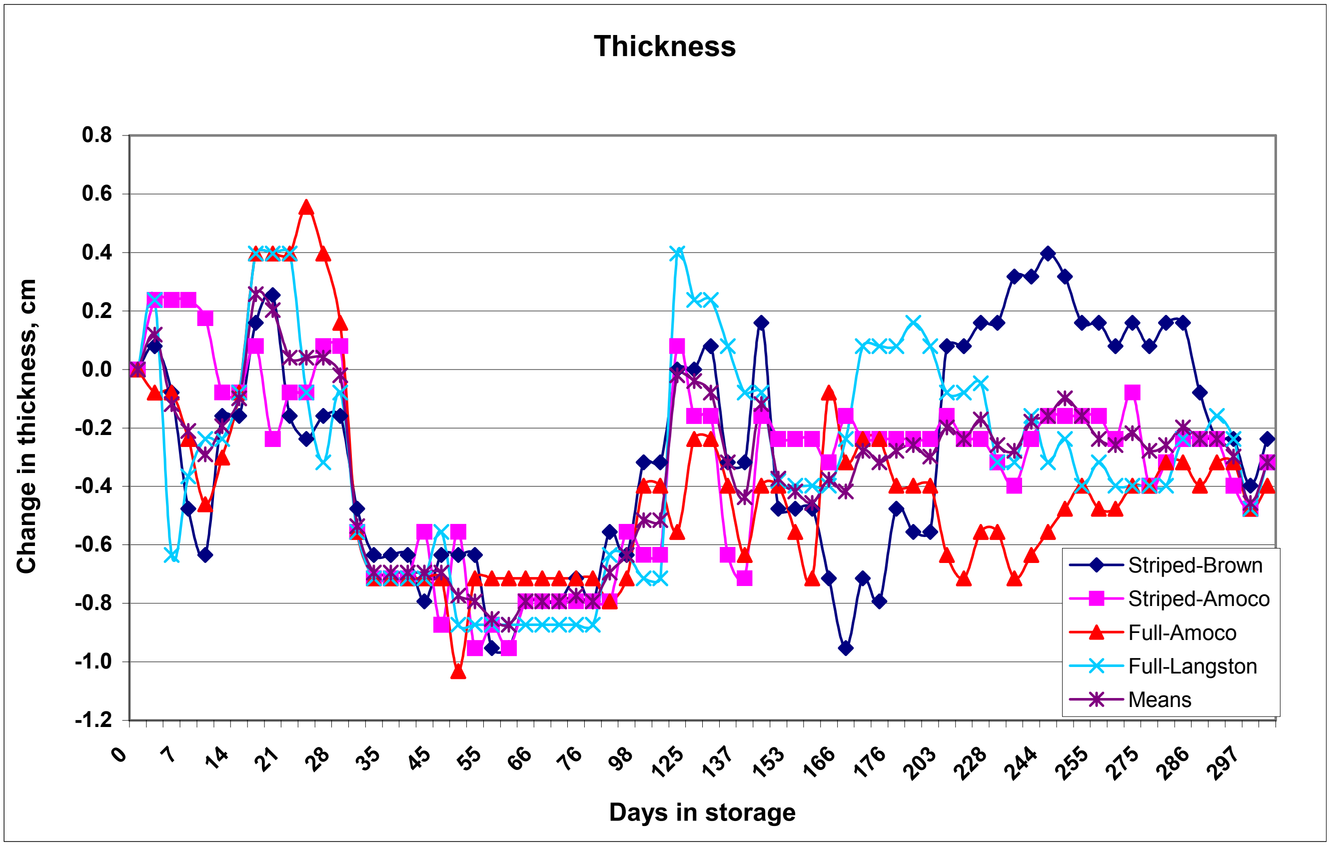

Figure 12. Bale thickness at humps for Phase III for 305 days of storage at 21.1° C (70° F) and 50% relative humidity.

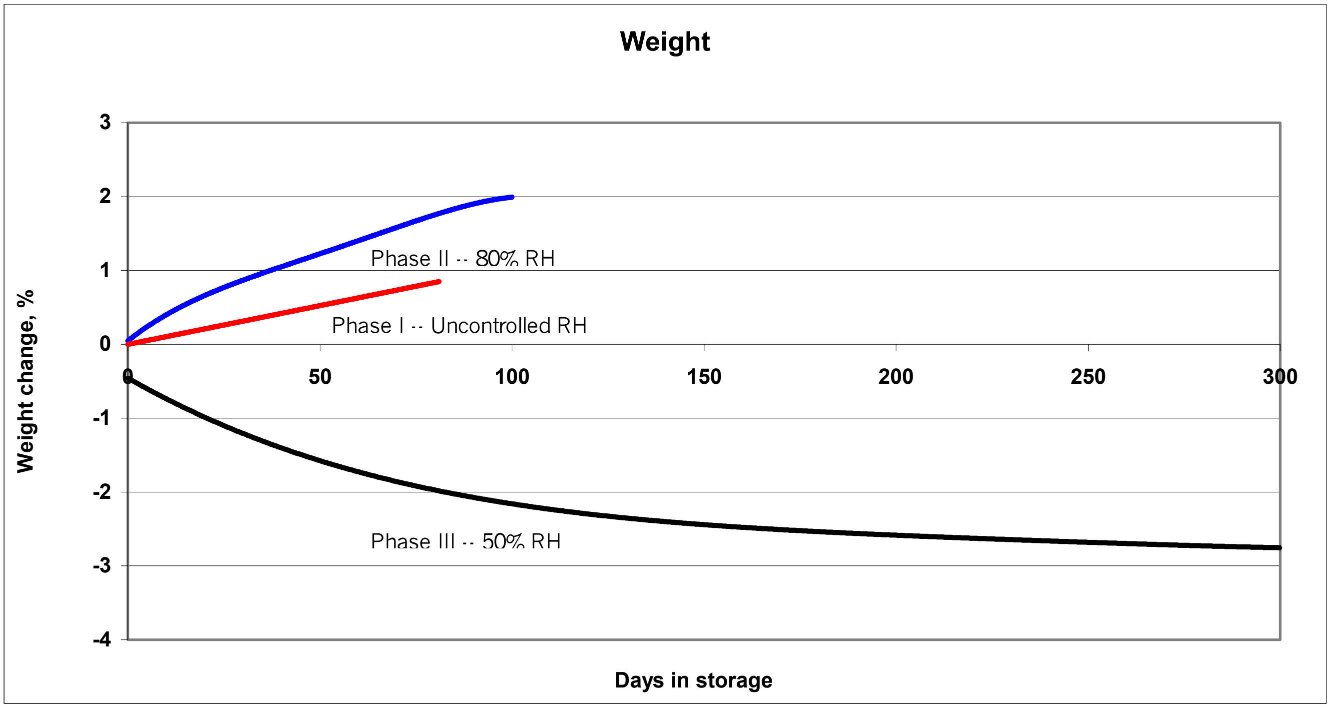

Figure 13. Means for weight change, %, across Phase I, Phase II, and Phase III. Data for days 125-305 in Phase III were not substantially different after day 125.

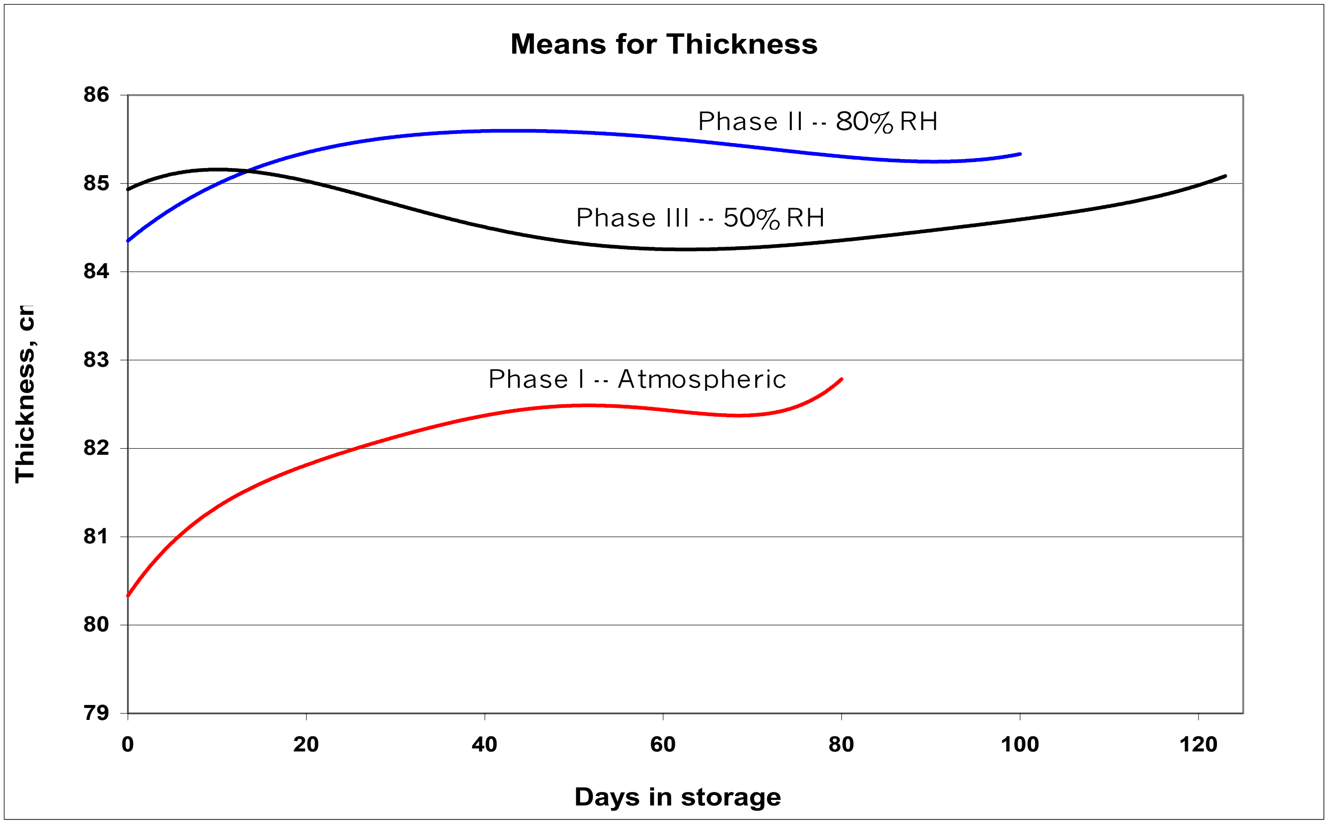

Figure 14. Means for thickness across Phase I, Phase II, and Phase III. Data for days 125-305 in Phase III were not substantially different from day 120 and are not shown in order to provide adequate resolution in one figure. Note that bales were not bagged for Phase I, and the thickness at "hump" was measured; for Phases I and III, the bales were bagged in four types of bagging and only one "hump" was measured.